

EXTIRPATION OF A POPULATION OF *CICINDELA PATRUELA* DEJEAN  
(COLEOPTERA: CARABIDAE: CICINDELINI) IN SUBURBAN  
WASHINGTON, D.C., USA

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*Abstract.*—A population of *Cicindela patruela patruela* DeJean (Coleoptera: Carabidae: Cicindelini) existed until at least 1950 in a small area of eastern Washington, D.C., and adjacent Prince George's County, Maryland, USA. Suitable habitat for this population consisted of open sandy barrens with soils derived from Cretaceous sediments of the Potomac Group and vegetation characterized by oak and pine species, particularly *Quercus marilandica* Münchhausen and *Pinus rigida* Miller. This habitat was eliminated in the Washington area by extensive suburban housing construction, which was driven by rapid growth in the human population. Recommendations are provided for the reintroduction of *C. patruela* and for the restoration of suitable habitat at remnant natural areas.

*Key Words:* *Cicindela patruela*, tiger beetle, extirpation, conservation, restoration, management

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Washington, D.C., and its suburbs are among the most richly sampled areas for tiger beetles in the world. Over the past 120 years, scientists from the Smithsonian Institution's National Museum of Natural History (NMNH) and the U.S. Department of Agriculture's Systematic Entomology Laboratory have repeatedly collected specimens of these beetles. A recent inventory by the author of material preserved in the NMNH collections found that 1,105 tiger beetle specimens, representing 14 species, had been collected since 1885 in the District of Columbia and adjacent municipalities in Maryland and Virginia.

Of these fourteen species, only three are still widespread and abundant in the Washington suburbs (*C. punctulata* Olivier, *C. repanda* DeJean, and *C. sexguttata* Fabricius), and several species have probably been extirpated from this area (Glaser 1984, Knisley and Schultz 1997, Mawdsley, un-

published data). Glaser (1984) suggested that the declines of certain tiger beetle species in the Washington metropolitan area may be due to a loss of habitat resulting from rapid urban and suburban development.

To test this hypothesis, I analyze data here from museum specimens of *Cicindela patruela patruela* DeJean. From 1918 to 1950, adults of this species were routinely collected in a small area of the eastern District of Columbia and adjacent parts of Prince George's County, Maryland. *Cicindela patruela* has not been found in the Washington area since 1950 (Glaser 1984, 1995; Knisley and Schultz 1997), despite intensive collecting efforts over the past fifty years.

*Cicindela patruela* is distributed widely throughout eastern North America (Pearson et al. 1999) but occurs in small localized populations throughout much of its range

(Glaser 1995, Willis 2001). Populations of *C. patruela* are monitored by state conservation agencies (e.g., New York State Department of Environmental Conservation 2003, Pennsylvania Department of Conservation and Natural Resources 2003). In addition, *C. patruela* is currently listed as a species of special concern by the states of Massachusetts (Massachusetts Division of Fisheries and Wildlife 2003), Minnesota (Minnesota Department of Natural Resources 2003), and Wisconsin (Wisconsin Department of Natural Resources 2003). Given the current conservation interest in *C. patruela* and other tiger beetles (Knisley and Schultz 1997, Pearson and Vogler 2001), it was felt that a more extensive account of this population and its demise would be appropriate and relevant to conservation efforts.

Data associated with museum specimens and other historical data also allow the reconstruction of some details of the biology of this population, including its seasonal cycle and associated vegetative communities and soil types. Although aspects of the biology of *C. patruela* have been described by Lawton (1970), Boyd (1978), Knisley et al. (1990), and Willis (2000, 2001), uncertainties still exist regarding the habitat associations of piedmont and coastal plain populations (Knisley and Schultz 1997).

#### MATERIALS AND METHODS

As part of the larger tiger beetle inventory effort described above, pinned adult specimens of *C. patruela* were examined in the collection of the National Museum of Natural History, Smithsonian Institution. Complete specimen label data were recorded from specimens collected in Virginia, Maryland, Pennsylvania, and the District of Columbia; data relevant to this paper are given in the Appendix. Collecting localities were identified on paper and digital maps of the Washington, D.C., region.

For purposes of this paper, the Washington, D.C., metropolitan area is defined to include the District of Columbia and adja-

cent municipalities in Maryland (Montgomery and Prince George's counties) and Virginia (Arlington and Fairfax counties and the City of Alexandria).

Information on historical vegetation and statistics on housing development in the town of Cheverly, Maryland, were obtained from Bellamy (2000). Historical census data for Prince George's County, Maryland, were obtained from the online databases of the Maryland State Data Center (2003) and the U.S. Census Bureau (2004).

Information regarding recent collections of tiger beetles in Prince George's County, Maryland, was provided by Warren E. Steiner, Jr. Additional information was obtained by the author through visits to natural areas in Prince George's County and the District of Columbia between 2000 and 2004.

#### ANALYSIS OF EXTIRPATION

*Cicindela patruela* is undoubtedly extirpated from the Washington metropolitan area, as specimens of this species have not been collected in Prince George's County or the District of Columbia since 1950. The tiger beetle fauna of Prince George's County was extensively collected by D. G. Shapirio in the early 1950s and by G. Hevel and W. E. Steiner, Jr., in the late 1960s and early 1970s. Specimens from these collecting efforts are preserved in NMNH and do not include any representatives of *C. patruela*. More recent surveys by the author and others at remnant natural areas within the historic distribution of *C. patruela* have failed to locate any individuals of this species. Warren E. Steiner, Jr. has collected tiger beetles in Cheverly, Maryland (site of the largest historic population of *C. patruela* in the Washington area), since 1991 and has never encountered this species in Cheverly.

The period of decline and extirpation of *C. patruela* corresponds to a period of intense growth in both the human population and the number of houses in Prince George's County (Bellamy 2000). Table 1

Table 1. Comparison by decade of the rate of growth of the human population in Prince George's County, Maryland, the number of new houses built in the Town of Cheverly, Maryland, and the numbers of museum specimens of *Cicindela patruela* collected from Prince George's County and the Town of Cheverly.

Years	Rate of Growth— Human Population, Prince George's Co.	Specimens— Total for County	Number of New Houses Built, Town of Cheverly	Specimens— Total for Cheverly
1901–1910	20.90%	0	0	0
1911–1920	19.92%	8	0	0
1921–1930	38.64%	0	73	0
1931–1940	48.91%	42	207	27
1941–1950	117.0%	3	731	0
1951–1960	84.05%	0	400	0
1961–1970	84.83%	0	504	0
1971–1980	0.6818%	0	165	0
1981–1990	9.545%	0	103	0

compares *C. patruela* collection records with the human population growth rate in this county. The last collections of *C. patruela* were in 1948, 1949, and 1950, at the end of a ten-year period in which the county's population grew by 117%, the highest growth rate for any decade in the twentieth century.

Obviously these incoming residents required new houses. Data on housing construction were available for the Town of Cheverly, site of the largest *C. patruela* population in the Washington area (Table 1). As would be expected, the number of new houses is strongly correlated with the human population growth rate (from simple linear regression,  $P = 0.0006$ ). The *C. patruela* population in Cheverly was first encountered by collectors in 1931 and was last sampled in 1934. During the decade 1931–1940, the number of houses in Cheverly nearly quadrupled, from 74 to 281 units. Further construction and associated landscaping of an additional 1,635 houses during the period 1941–1970 eliminated the remaining open barrens habitat in Cheverly (Bellamy 2000).

Other factors that have been proposed as causes of tiger beetle population declines include trampling by pedestrians or vehicles, over-collecting, and pesticide spraying (Knisley and Schultz 1997). There is no evidence that trampling or pesticide spraying would have played a role in the decline of

*C. patruela* in the Washington area, and it is unlikely that the small numbers of specimens that were collected (54 specimens collected over 32 years) would have had a significant impact on the larger population. Knisley and Schultz (1997) review the available scientific evidence supporting various hypotheses which have been proposed to explain tiger beetle declines and conclude that habitat destruction and degradation are easily the most important factors driving population declines.

In summary, the available evidence indicates that the extirpation of *C. patruela* from the Washington metropolitan area was caused by a loss of suitable habitat due to suburban housing construction, which was driven in turn by substantial growth in the human population.

#### HABITAT CHARACTERIZATION

The historical collecting sites of *C. patruela* in the District of Columbia and western Prince George's County are all clustered on low hills overlooking the confluence of several streams to form the Anacostia River. It is interesting to note that *C. patruela* was not collected at other localities in the Washington area which were well-sampled for tiger beetles during the first half of the 20th century, such as Plummers Island in Maryland (5 species of tiger beetles recorded), Rock Creek Park in the District of Columbia (8 species recorded), and Falls Church



Table 2. Numbers of tiger beetle specimens in NMNH collected at sites with *Cicindela patruela* in the District of Columbia and Prince George's County, Maryland.

	D.C.		Maryland				Totals
	Woodridge	Bladensburg	Cheverly	College Park	Hyattsville	Riverdale	
<i>C. patruela</i> DeJean	1	5	27	11	8	1	53
<i>C. punctulata</i> Olivier	0	0	1	0	0	0	1
<i>C. purpurea</i> Olivier	1	0	19	10	4	0	34
<i>C. repanda</i> DeJean	1	2	1	3	0	2	9
<i>C. rufiventris</i> DeJean	0	0	0	2	0	0	2
<i>C. scutellaris</i> Say	1	0	4	8	2	1	16
<i>C. sexguttata</i> Fabricius	6	2	14	3	0	4	29
<i>C. splendida</i> Hentz	0	1	0	0	0	0	1
<i>C. tranquebarica</i> Herbst	4	4	5	2	2	1	18
<i>C. unipunctata</i> Fabricius	0	0	2	1	0	0	3
Total by site	14	14	73	40	16	9	166

(5 species recorded) and Mount Vernon (6 species recorded) in Virginia. The absence of historical specimens from these well-sampled localities suggests that the distribution of *C. patruela* was quite restricted, even in the early 20th century.

Comparisons with the geological map of Maryland (Maryland Geological Survey 1968) indicate that the historical collecting sites discussed here are all located on soils derived from the Cretaceous Potomac Group, characterized as "interbedded quartzose gravels; protoquartzitic to orthoquartzitic argillaceous sands; and white, dark gray and multicolored silts and clays." This formation extends in a northeastern direction into Anne Arundel and Baltimore counties, paralleling the historic distribution of *C. patruela* on Maryland's coastal plain (as mapped by Knisley and Schultz 1997). The limited ecological information on museum specimen labels indicates an association with sandy soils, similar to that found elsewhere in this species' range (Knisley et al. 1990, Willis 2000).

Bellamy (2000) characterized the vegetation of Cheverly, Maryland, as "locust and scrub pine" that had grown up on soils depleted of nutrients by past tobacco farming practices. Museum specimen labels suggest that the historic collecting sites were open, sandy barrens with scattered pines and deciduous trees. Based on current veg-

etation at the collecting sites, tree species present in these barrens would have included blackjack oak (*Quercus marilandica* Münchhausen) and pitch pine (*Pinus rigida* Miller) (W. E. Steiner, Jr., personal communication). *Cicindela patruela* is associated with oak and pine barrens in other parts of its range (Boyd 1978, Knisley et al. 1990, Knisley and Schultz 1997, Willis 2000).

#### ASSOCIATED TIGER BEETLE SPECIES

Many authors have noted the existence of well-defined assemblages of tiger beetle species in particular habitats (see discussion in Knisley and Schultz 1997). Data from the author's museum specimen inventory (described above) allow a tentative reconstruction of historic tiger beetle assemblages in the Washington area, including assemblages that included *C. patruela*. Table 2 lists the numbers of specimens of nine other species of *Cicindela* which were collected at the same sites and at approximately the same time of the year as the *C. patruela* specimens listed in the Appendix. *Cicindela purpurea* Olivier and *C. sexguttata* Fabricius appear to have been the most common associates of *C. patruela*, although *C. scutellaris* Say and *C. tranquebarica* Herbst were also well represented at *C. patruela* sites.

## POPULATION SEASONALITY

Seasonality of the Washington, D.C., population of *C. patruela* can be inferred from dates when specimens were collected. Adult activity was evidently on a spring-fall cycle, as in other populations of this species (Knisley and Schultz 1997). The spring activity period appears to have been between the end of March and late June, while the fall activity period appears to have been from early September to early October.

## OPPORTUNITIES FOR HABITAT RESTORATION AND REINTRODUCTION

Much of the literature on tiger beetle conservation has focused on identifying immediate threats to individual populations and documenting the causes of population declines (see, for example, the numerous citations in Knisley and Schultz 1997). Often overlooked are two key facts: simple management practices can greatly increase the available habitat for these beetles (Wilson 1970, Kritsky et al. 1999), and equally simple techniques can be used to successfully reintroduce tiger beetle species to restored habitat (Knisley and Hill 2001, Scherer 1999, Brust 2002).

Given the extent of urbanization in Prince George's County, Maryland, habitat restoration for *C. patruela* and other pine/oak barrens species would be most feasible on several large, publicly-owned tracts of land which are managed by the United States Department of Agriculture (Beltsville Agricultural Research Center), the National Park Service (Greenbelt Park) and the U.S. Fish and Wildlife Service (Patuxent Research Refuge). Potomac Group soils underlie much of these tracts, and the barrens tree species listed above are found in some of the closed-canopy forests on ridges and other upland areas.

Restoration activities for tiger beetles on these properties would consist primarily of vegetation management, with the overall goal of maintaining an early successional native plant community with open areas of

bare sandy soil. The presence of mosses, lichens, and sedges is characteristic of *C. patruela* microhabitats and oviposition sites in Ohio (Knisley et al. 1997) and Wisconsin (Willis 2000), so restoration and management activities should be designed to promote the growth of these species. Periodic mechanical thinning or fire management (as appropriate for the site) would be necessary to control tree and shrub growth and prevent full canopy closure. Native vegetation control will need to focus on species such as Virginia pine (*Pinus virginiana* Miller), black locust (*Robinia pseudoacacia* L.), chestnut oak (*Quercus castanea* Née), and white oak (*Quercus alba* L.), which aggressively colonize open sandy barrens (W. E. Steiner, Jr., personal communication). Herbicide treatments may be necessary to control invasive, non-native vegetation or aggressive natives. Knisley and Schultz (1997) reported that the herbicide glyphosate in its Rodeo® formulation has no adverse effects on larvae of *C. dorsalis* Say.

Reintroduction of *C. patruela* at restored barrens sites may be advisable if no natural populations survive close enough to repopulate restored areas. Although translocations of *C. patruela* have not yet been attempted, simple yet effective strategies for reintroducing adult and larval tiger beetles have been described in the literature. Brust (2002) reported success at establishing a viable *C. formosa* Say population after releasing adults of this species at a restored sand dune in Wisconsin. However, similar translocation attempts with adults of the threatened species *C. dorsalis* Say and *C. puritana* Horn failed, due probably to dispersal of adults immediately after release (Hill and Knisley 1993, Knisley and Hill 2001). Knisley and Hill (2001) successfully established a population of *C. dorsalis* at Sandy Hook, New Jersey, by translocating larvae. Methods for translocating adult tiger beetles are described by Brust (2002) and methods for translocating larvae are described by Knisley and Hill (2001). Potential source populations for *C. patruela* re-

introductions can be found in western Maryland, Virginia, West Virginia, and Pennsylvania.

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APPENDIX

Collections of *Cicindela patruela* DeJean from the Washington, D.C., metropolitan area, as documented by specimens in the National Museum of Natural History, Smithsonian Institution.

DISTRICT OF COLUMBIA: Washington: Woodridge, 31.III.1918 (1 ♀).

MARYLAND: Prince George's County: Bladensburg, 20.IV.1919 (2 ♂), 1.VI.1919 (1 ♂), 21.VI.1920 (2 ♀); Cheverly,

VII.1931 (1 ♂), VIII.1931 (2 ♀), 6.IX.1931 (1 ♂, 2 ♀), 10.V.1933 (3 ♂, 1 ♀), 17.V.1933 (3 ♂, 1 ♀), 21.V.1933 (2 ♂, 2 ♀), 10.IX.1933 (4 ♂, 4 ♀), 22.VI.1934 (1 ♀); College Park, 21.IV.1939, in sun on sparse pine & deciduous wooded hillside, sandy (5 ♂, 2 ♀), same data except 21.IX.1939 (1 ♂), 5.X.1940, on sandy bare spot on pine-deciduous hillside (1 ♀), 10.IV.1949 (1 ♂), 17.IX.1950 (1 ♀); Hyattsville, 3.V.1918 (1 ♂, 1 ♀), 6.IX.1933, (2 ♂, 4 ♀); Riverdale,? .V.1919 (1 ♀); no locality specified, 12.VI.1948 (1 ♀).